

2009 Roads and Bridges Conference

EW-06

Interchange Design with Roadway Designer

Presenter: Denis Schaffer, Bentley Civil, Advisory Software Developer

Bentley Systems, Incorporated
685 Stockton Drive
Exton, PA 19341
www.bentley.com

Lesson Name: Opening a Project (InRoads User)

LESSON OBJECTIVE:

In this lesson the student will learn to access an InRoads project in preparation for designing a model in Roadway Designer. Note, this lesson is for InRoads users only. For GEOPAK users, please proceed to the next lesson on the next page.

EXERCISE: GETTING STARTED (INROADS USER)

This exercise will guide you through the steps to get started

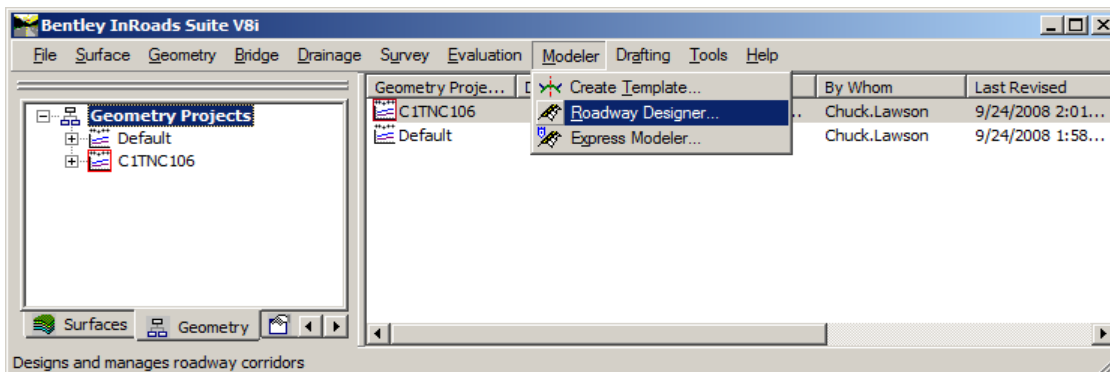
1. Go to **Start > Programs > Bentley > InRoads Group Athens > InRoads Suite**.
2. When the MicroStation Manager appears select the file:
C:\2009 RBC\EW-6\DATA\EW-6.dgn and press **Open**.
3. When the InRoads Explorer appears, go to **File > Open** from the InRoads menu.
4. When the Open dialog appears select the InRoads project file:

C:\2009 RBC\EW-6\DATA\EW_6.rwk and press **Open**.

Opening the *RWK* project file opens the following files:

EW-6.alg
EW-6.itl
EW-6.ird
Existing.dtm
EW-6.xin

5. Select **Modeler > Roadway Designer** from the InRoads Explorer menu to access Roadway Designer.



LESSON NAME: ADJUSTING RAMP SUPERELEVATION

LESSON OBJECTIVE:

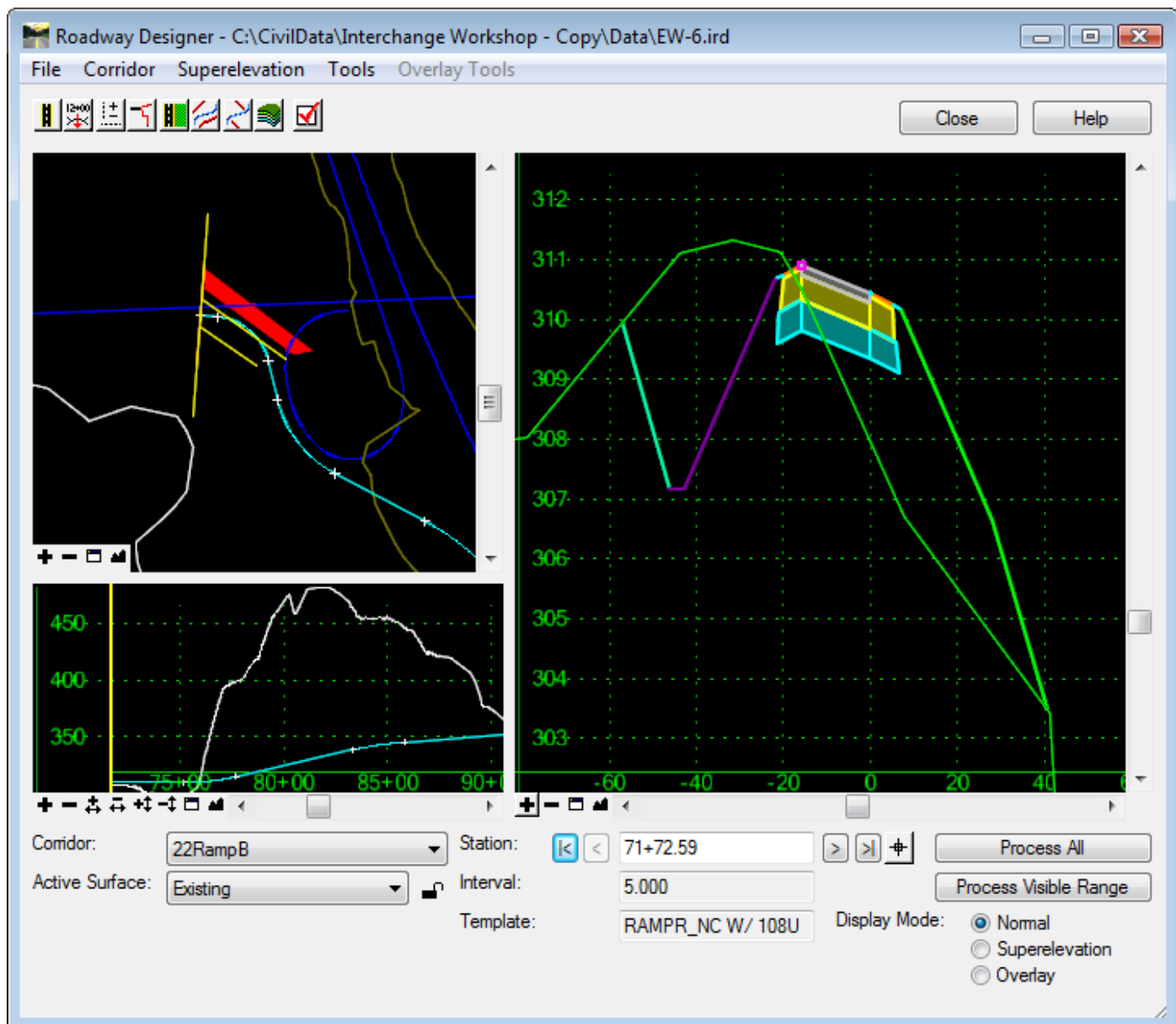
This lesson will take you through how to adjust the super elevation of a ramp to match the cross slope of the corridor.

[On-Line Help Topic:](#) Search on “Superelevation Control Line”

EXERCISE: ADJUSTING RAMP SUPERELEVATION

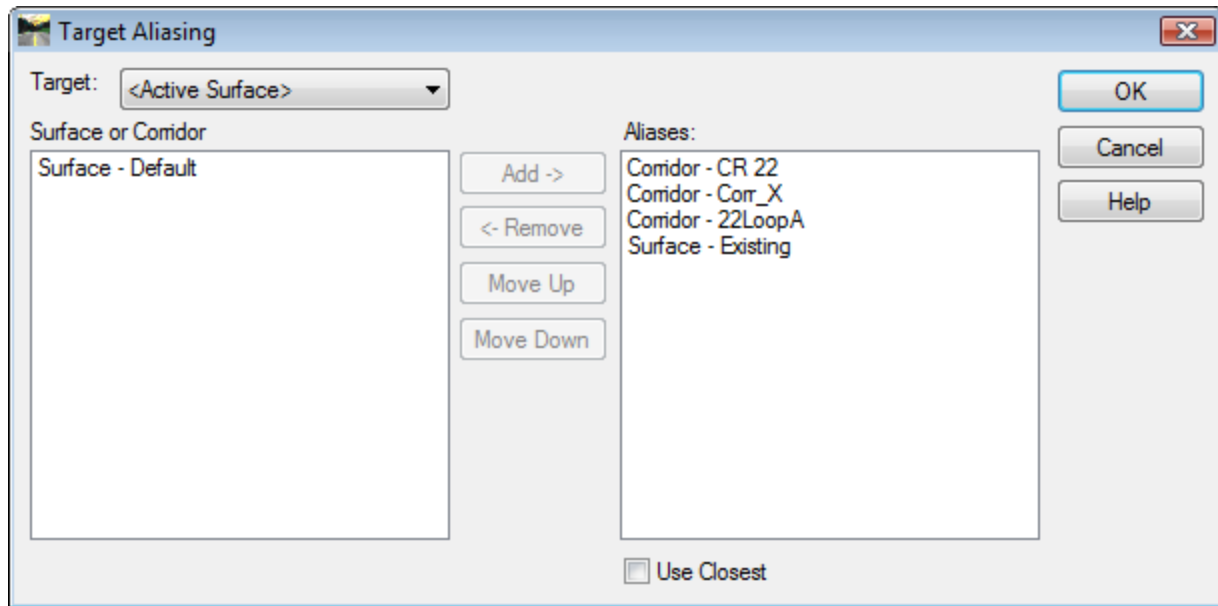
This exercise will take you through adjusting the ramp super elevation to match the road superelevation.

When the **Roadway Designer** opens, make sure that **22RampB** is the selected corridor (combo box on the bottom right).

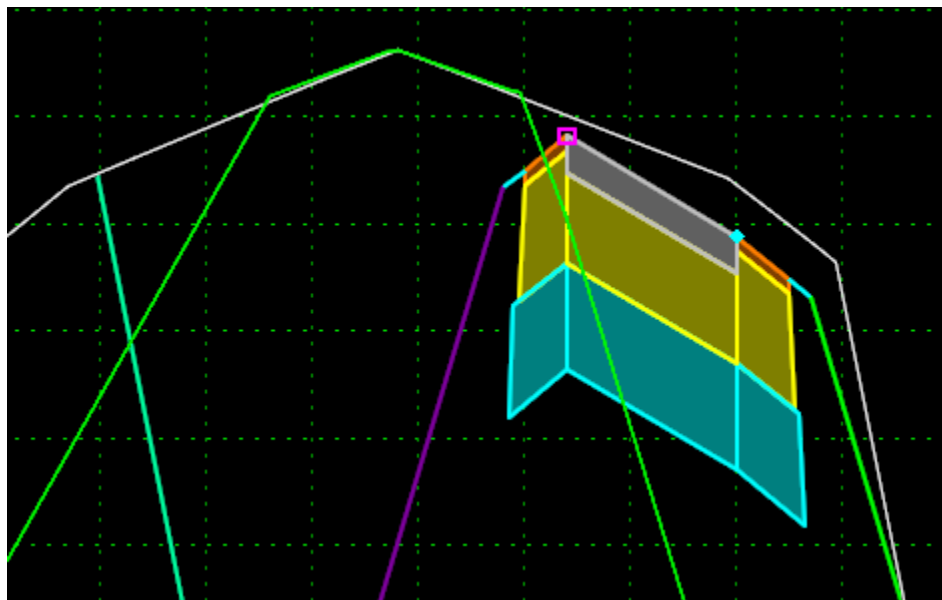


1. Select **Tools > Target Aliasing** from the menu on the **Roadway Designer**.

Add all the corridors (22LoopA, Corr_X, and CR22), and surface, Existing, to the Alias list. This is done by selecting the corridors and surface and pressing the **Add ->** button. The order should be as shown in the figure below. If they are not in the proper order, select the Alias to move and use the **Move Up** and **Move Down** buttons to reorder the list.

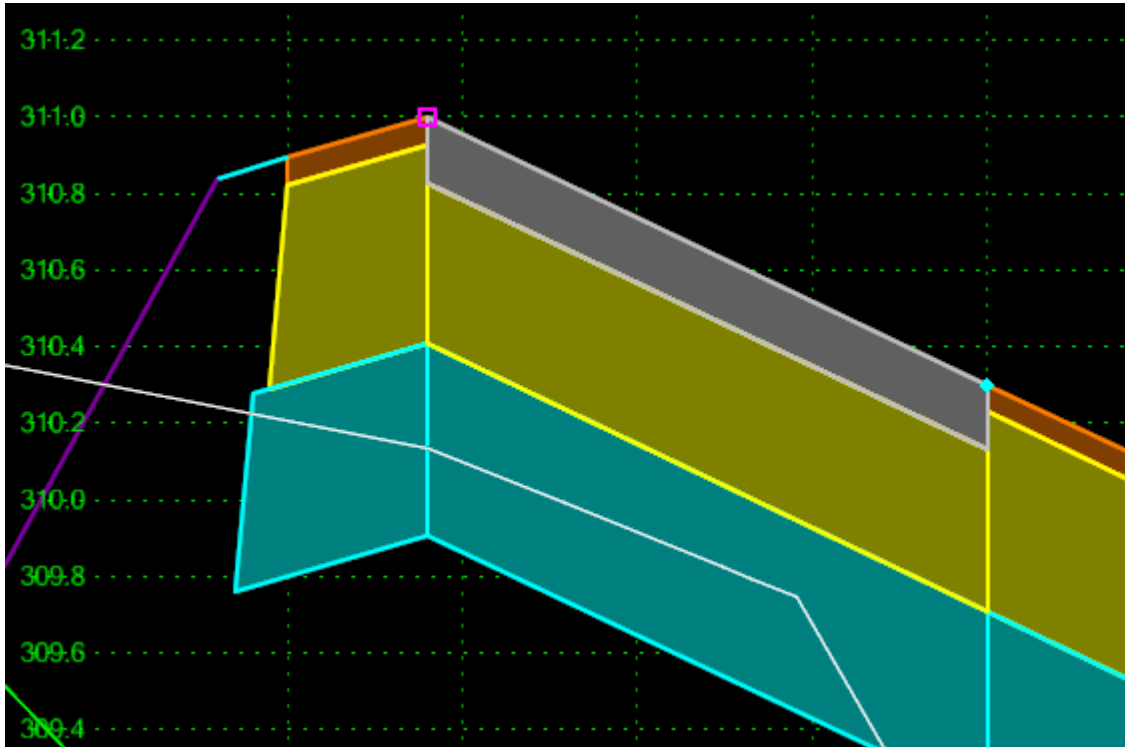


2. **Close** the **Target Aliasing** dialog.
3. On the **Roadway Designer** dialog click the **Process All**. You should now see the line representing Corridor: CR 22 in the cross section view

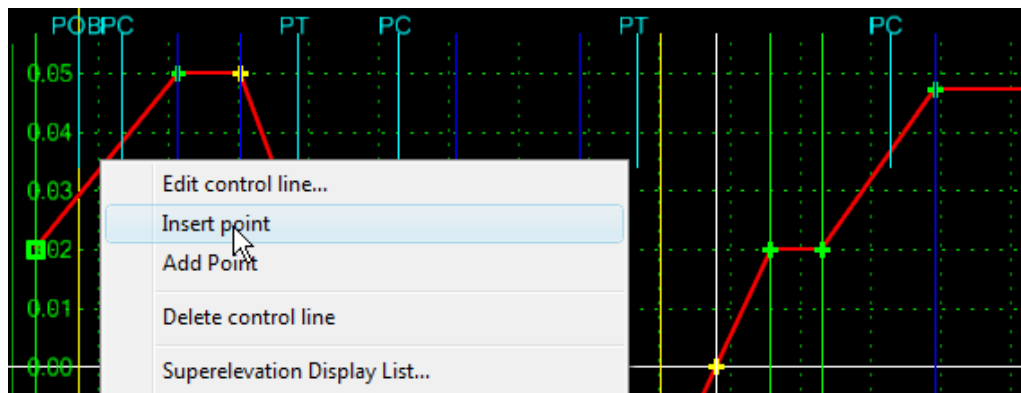


4. We want the cross slope of our ramp to match the cross slope of the CR 22 up to the point where the gore starts. To find the location where the gore starts, walk down the ramp corridor using the >(next) button until the LEP Point matches the horizontal location of the road REP. (Hint – this is at the first slope break on CR22 and should occur at Station 72+70.00). Setting the **Cross Section**

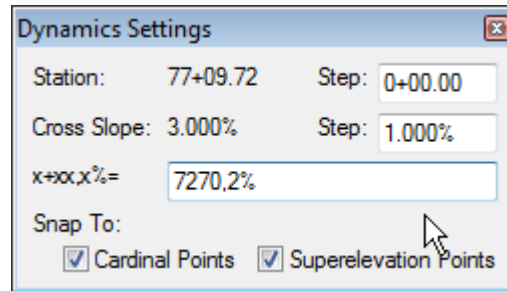
Display Properties to Center Backbone with a **Backbone Screen Width** of 60% or 70% should help facilitate this



5. On the lower right corner of the **Roadway Designer** dialog, change the **Display Mode** to **Superelevation**.
6. In the **Superelevation** view, right click on the first segment of the red control line and select **Insert Point**.

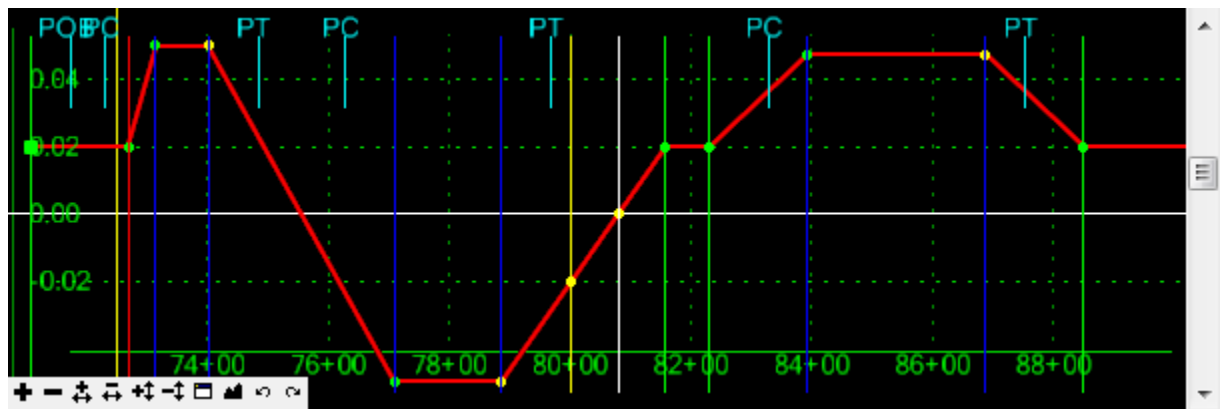


7. In the **Dynamic Settings** key in 7270,2% and press the Enter Key, then Right Click in the view and

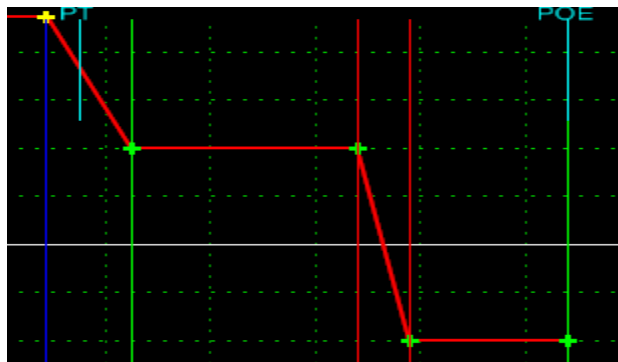


select **Finish**.

The Superelevation control line should look like this:



8. Switch the **Display Mode** back to **Normal**.
9. Walk up and down the ramp corridor from the beginning to 72+70 using the < and > buttons. Note that the cross slope of the ramp matches the cross slope of CR 22.
10. Select the **Process All** button.
11. Use a similar approach to match up the superelevation of the Ramp with the super elevation of Corr_X (Hint, should start 93+80.00 and be -2% from there to the end. Use a 100 foot transition from 92+80 at 2% to 93+80 at -2%). When you are done, the end of the super control line should look like this:



12. In the Roadway Designer dialog select **File > Save As** to save the Roadway Designer project file.
Name the file **My_Project.ird**

LESSON NAME: VERTICAL GORE TOOL

LESSON OBJECTIVE:

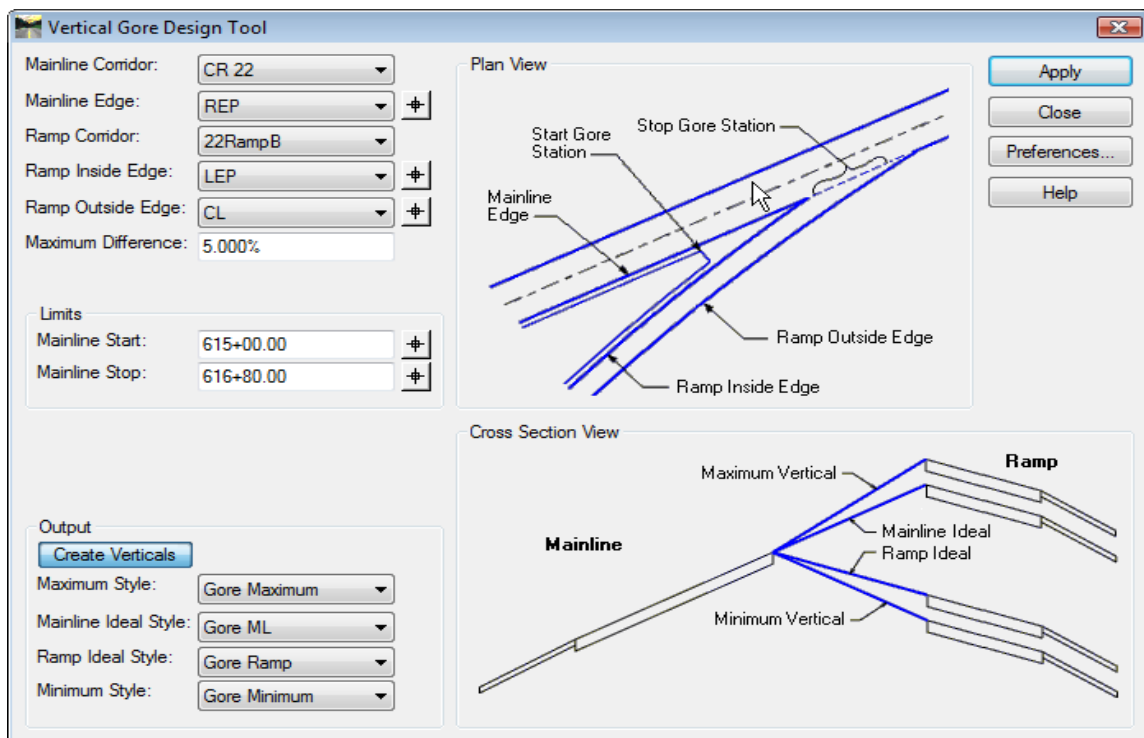
This lesson will show you how to use the **Roadway Designer Vertical Gore Tool** to aid in the design of vertical alignments (profiles) for ramps and any other road merges.

[On-Line Help Topic](#): Search on “vertical gore tool”

EXERCISE: TEMPLATE TRANSITIONS

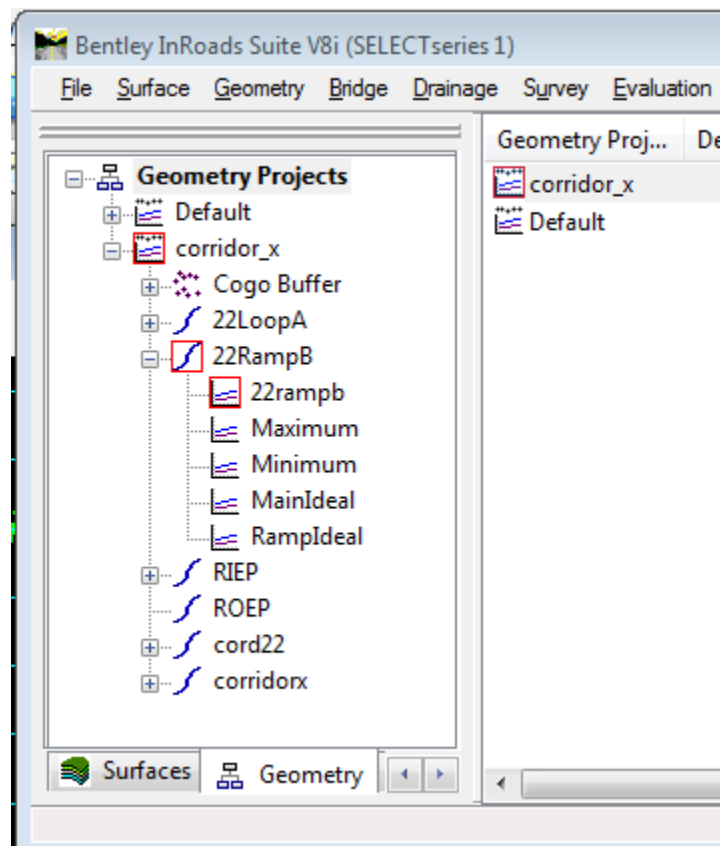
This exercise will take you through using the vertical gore tool to create temporary vertical alignments that can then be used to aid in the design of the final vertical profile. Before using this command, all mainline corridors must be designed, (include super elevation), and the ramp corridor must be designed to the point where super elevation has been applied, the vertical profile for the ramp does not be designed, and may be set to None initially.

1. From the **Roadway Designer** menu, select **Tools > Vertical Gore Tool**. Enter the settings as shown below.

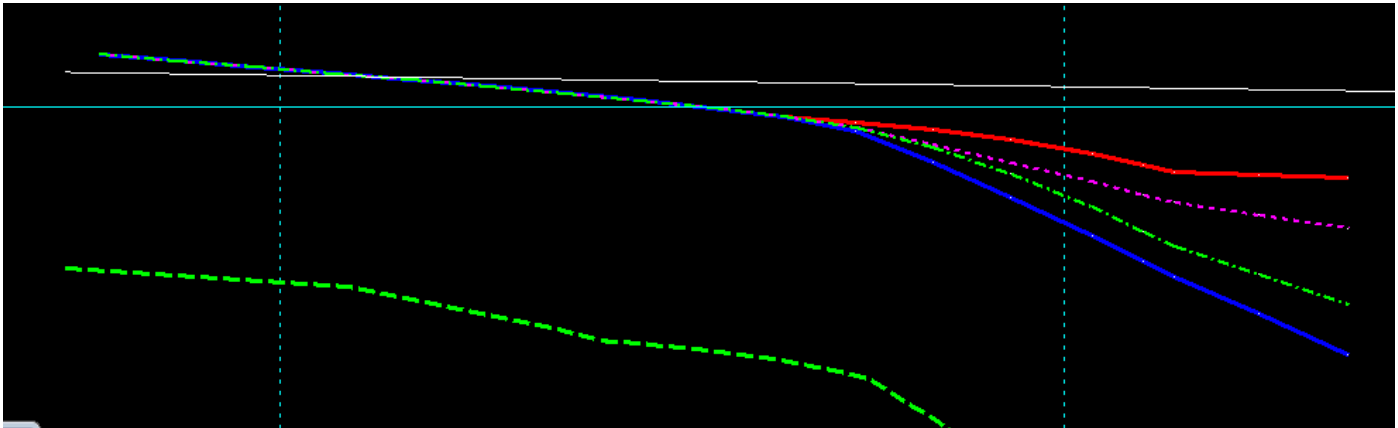


Note that the Mainline Start and Stop Stations do not need to be precise. You simply want to bound your gore, and the tool will take care of the rest.

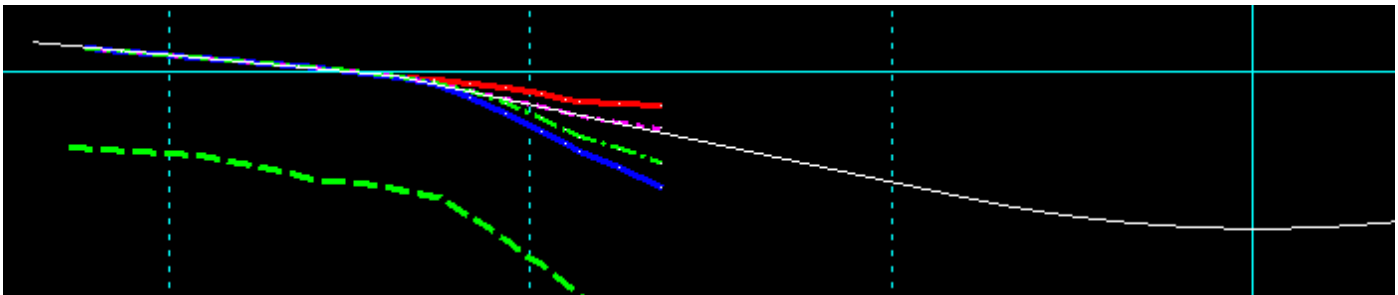
2. Once all the information has been entered, select the **Apply** button.
3. Close the **Vertical Gore Tool** dialog, and minimize **Roadway Designer**.
4. Set the view to the saved view **RampProfile** (keyin VI=RampProfile, and data point in the Microstation view).
5. Now from the **InRoads** explorer, Select the **Geometry** tab and expand the corridor_x > 22RampB leaf to show all the vertical alignments.



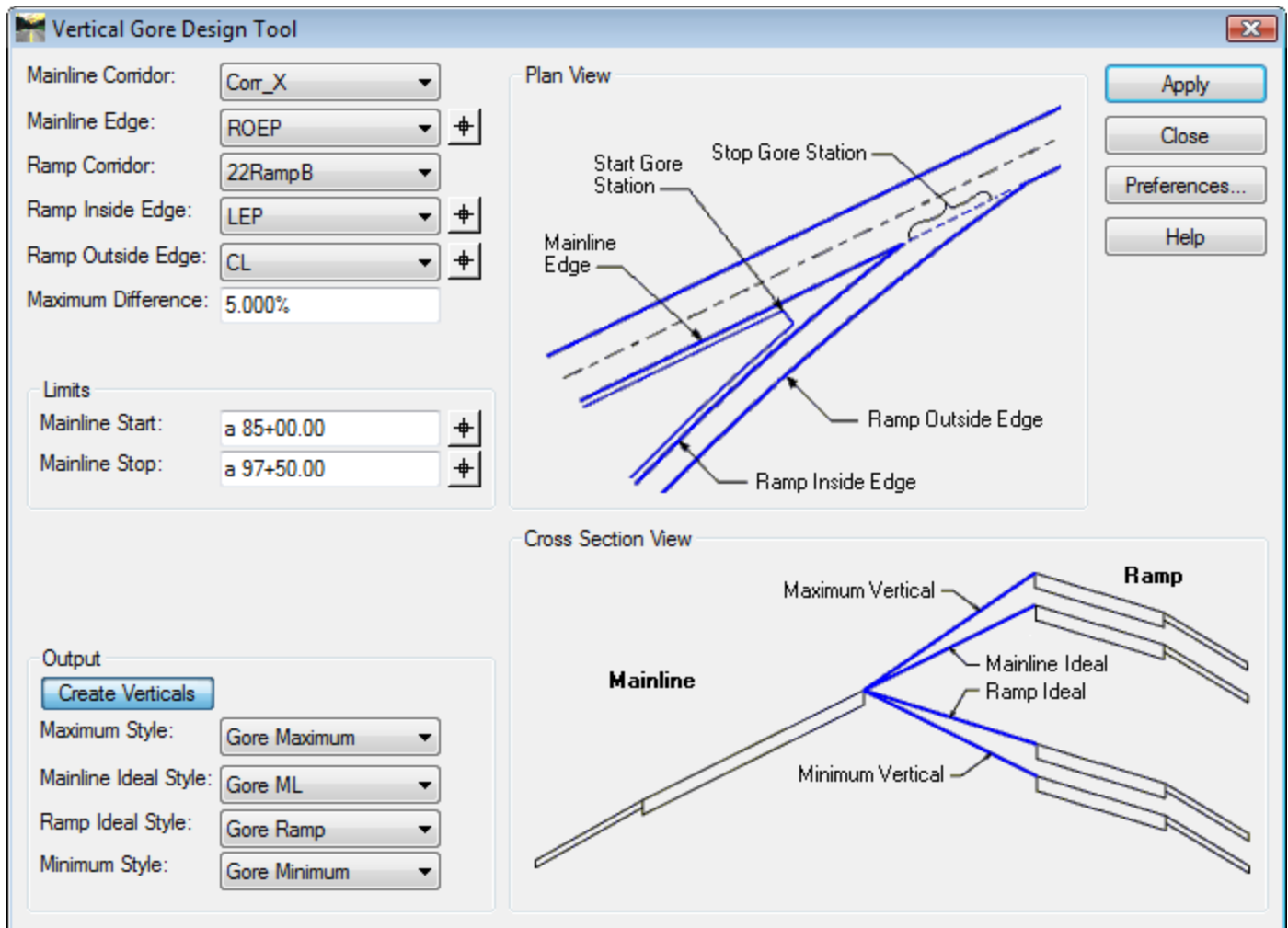
6. Right click on **Maximum** and select **View**. Do the same to view **Minimum**, **MainIdeal**, and **Ramp Ideal**.
7. Zoom in to the beginning of the alignment



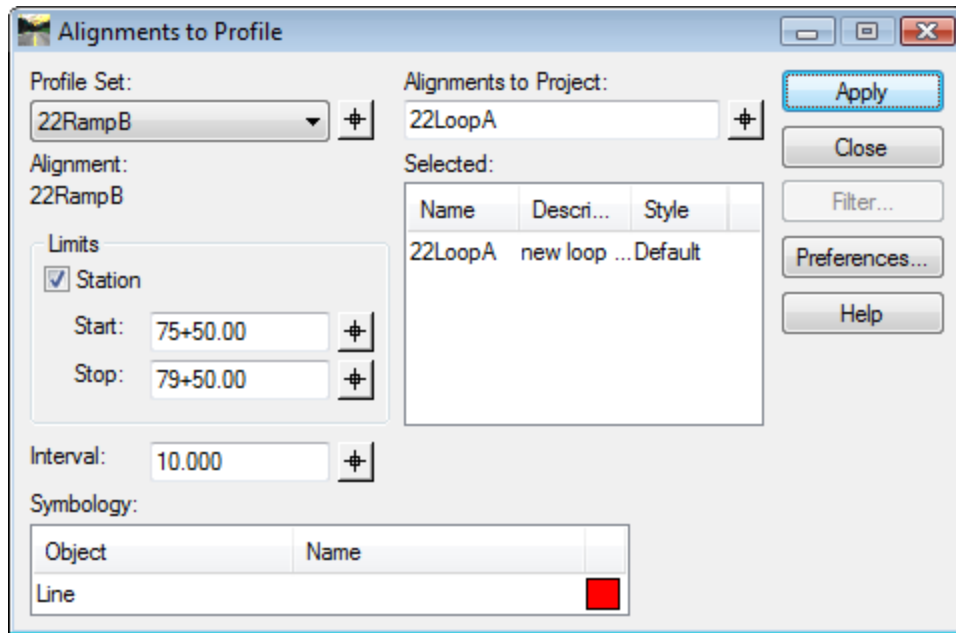
8. In the Explorer, Right click on the vertical alignment - 22rampb and select **Set Active**.
9. From the **InRoads** menu, use the **Geometry > Vertical Curve Set >** commands to modify the 22ramp profile to closely follow the MainIdeal (Purple dash). The two most important things are to ensure that the profile line passes directly through the beginning gore point (where all the gore profiles intersect, and that the ramp profile line has, roughly, the same slope entering the gore as the slope of all the gore profile lines immediately before the gore. After your done, it should look something like this:



10. Restore **Roadway Designer**, and go to the beginning of 22RampB. Notice that in the area where they overlap, CR22 and 22RampB match very closely. Before you begin our modifications for this gore area, let's finish modifying the alignment.
11. Select the **Vertical Gore Tool** again. Fill it in as follows:

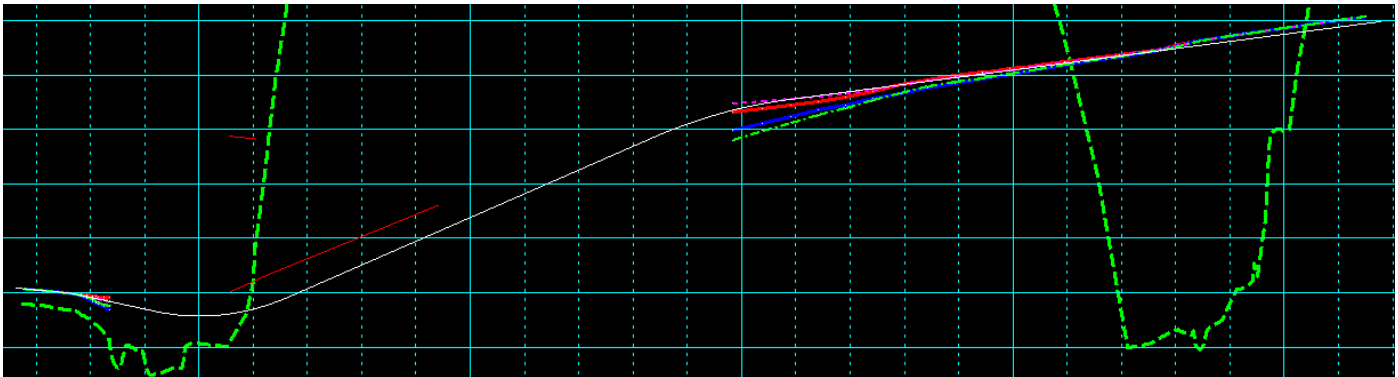


12. Press the **Apply** button. When prompted, replace each of the gore alignments with the new one.
13. As before, you are going to modify the 22rampb to follow the gore, but before you do, note that 22RampB is very close to 22LoopA from approximately 75+50 to 79+50, so before adjusting 22RampB's profile, you are going to project 22LoopA onto the profile window
14. Collapse Roadway Designer. From the InRoads menu, select **Evaluation > Profile > Alignments to Profile**. Fill out as follows:

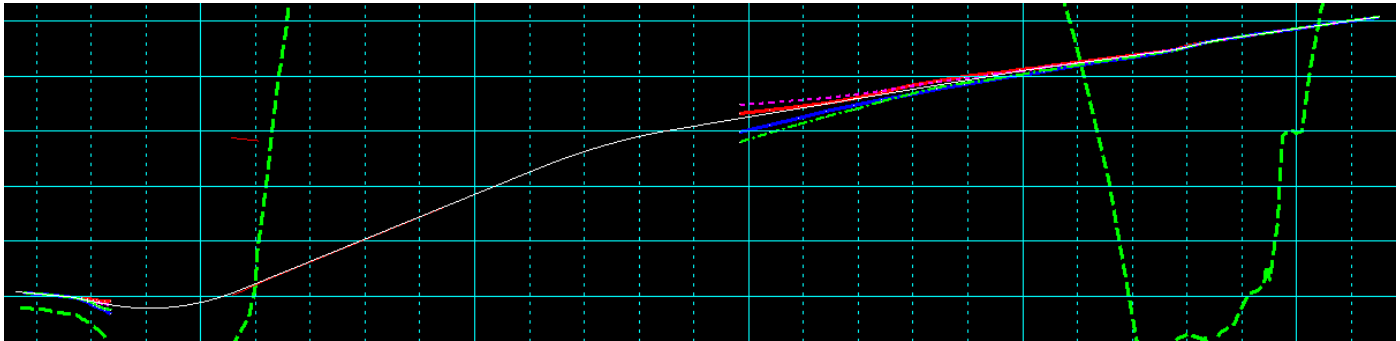


15. Using the previous steps, plot the gore profiles at the end of the alignment.

16. Your profile view should look something like this:



17. Use the vertical geometry commands to modify the ramp profile to match the gore at either end, and match the project loop profile as close as possible. Notice that the MainIdeal line at the end is OUTSIDE the Maximum and Minimum envelope, so make sure to keep the profile in that area between the Maximum and Minimum lines. When you are done, it should look something like this:



18. In the **InRoads** explorer window, right click and delete each of the gore profiles (Maximum, Minimum, MainIdeal, and RampIdeal).
19. From the **InRoads** menu, select **File > Save > Geometry Project**

LESSON NAME: CREATING THE GORE – METHOD 1

LESSON OBJECTIVE:

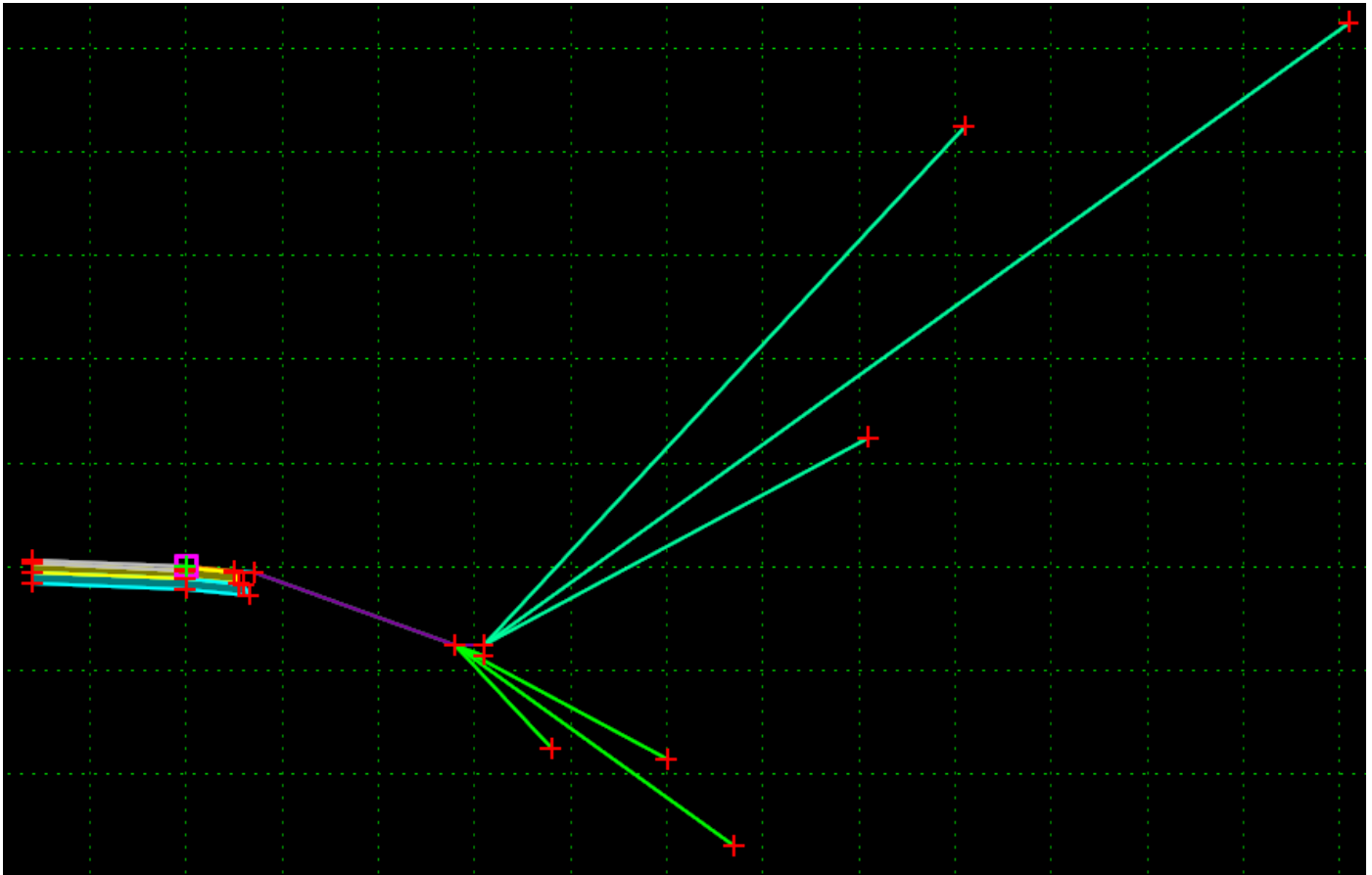
This lesson will show you how to design the ramp and gore area for a ramp being added to an existing road. It will use several of the tools available in **Roadway Designer**

[On-Line Help Topic](#): Search on “Roadway Designer”

EXERCISE: CREATING THE GORE – METHOD 1

This exercise will take you through tapering a ramp to match the existing road.

1. From the **Roadway Designer** navigate to the start of 22RampB. Walk down the ramp until the pavement section no longer overlaps the pavement of CR 22. (Station 72+75).
2. From the **Roadway Designer** menu, select **Corridor > Template Drops**. Copy the starting template drop to station 72+75.00 by selecting the template drop, then keying in 72+75 in the **Station:** field, and pressing the **Copy** button.
3. Select the first template drop, and press the **Edit** button. This will bring up the **Edit Template** dialog.
4. Delete all components to the left of point LEP. The resulting template should look like this:
Hint – the Delete Components tool available from the Right Click pop-up menu is very handy for this. Select this tool and Click and drag a line through all the components you want to delete.



5. Select **OK** on the **Edit Template** dialog, and close the **Template Drops** dialog.
6. From the Roadway designer menu, select **Corridor > Point Controls**.
7. On the **Point Controls** dialog box, select the vertical control in the list box, and change its start station to 72+75 (Use the **Change** button)
8. Add a new point control for **LEP** to control it both Horizontally and Vertically from the **CR 22 – REP** point from 71+72.56 to 72+70. Press the **Add** button to add it.

Point Controls

Corridor: 22RampB

Control Description:

Point: LEP

Mode
☐ Horizontal ☐ Vertical ☒ Both

Control Type: Corridor Point

Corridor: CR 22

Reference Point: REP

Station Limits
 Start: 71+72.59
 Stop: 72+70.00

Horizontal Offsets
 Start: 0.000
 Stop: 0.000

Vertical Offsets
 Start: 0.000
 Stop: 0.000

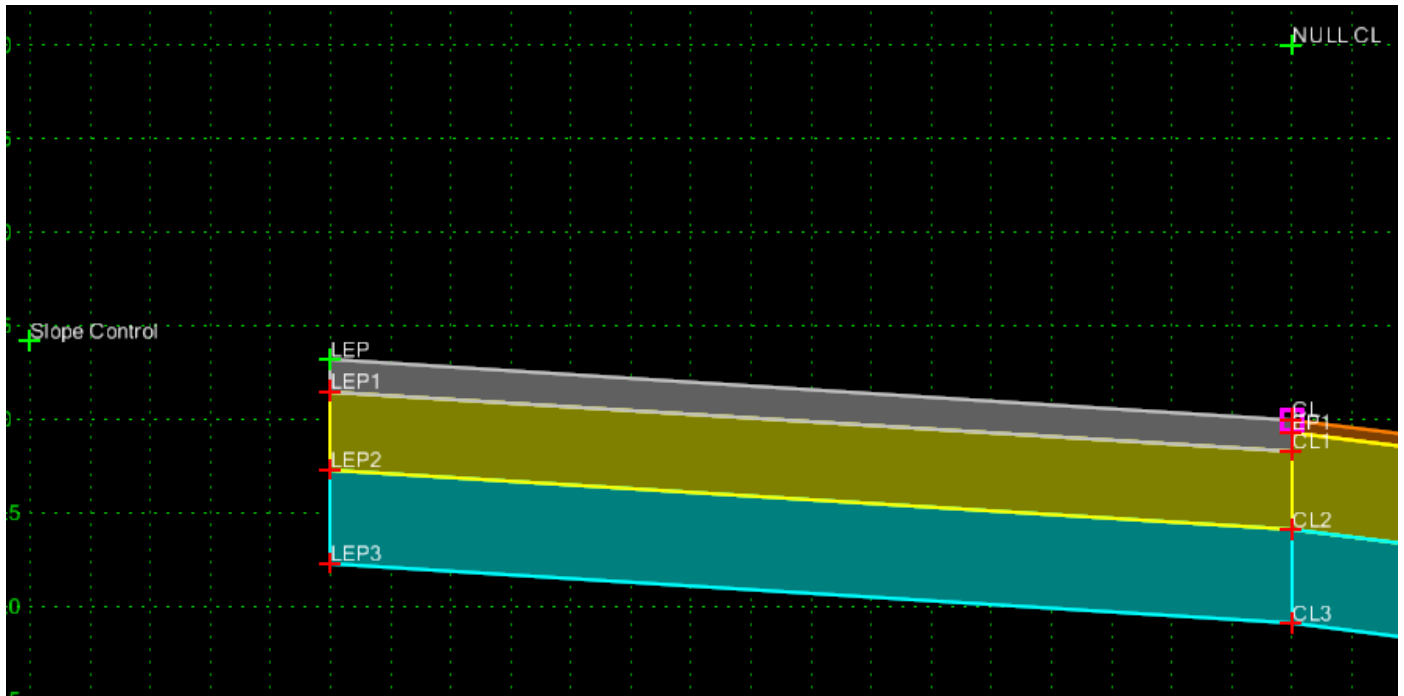
Priority: 1

Horizontal and Vertical Controls:

E...	P...	Name	Start St...	Stop St...	Mode	Type	Control	Description
X	1	LEP	71+72.59	72+70.00	Both	Corridor P...	CR 22:REP	
X	1	LEP	72+75.00	96+83.34	Vertical	Superelev...	CL-LEP:CL	

Buttons: Add, Close, Change, Help, Delete

9. Close the **Point Controls** dialog and view the cross sections of the ramp in the area before the gore. Unless you made your ramp profile precisely follow the gore profiles in the area before the gore, you will notice that the slope of the tapered portion of the ramp pavement is not correct. This can be solved by modifying the template. The approach we will use is generic, and can be used even in areas where the main road cross slope is changing.
10. Open the **Template Drops** dialog again and edit the first template drop.
11. Delete both constraints from point **LEP**.
12. Add a Null point called "**NULL CL**" at 0,2
13. Add a **horizontal** constraint to point **CL** from point **NULL CL**. The value should be 0.0.
14. Add a Null Point 5 feet to the left of **LEP** and at -2% slope(up to the left). Call this point "**Slope Control**"
15. Add a **vector offset** constraint to **CL** using a 0.0 offset and **Slope Control** and **LEP** as the parents.



16. Select **OK** to close the Edit Template dialog. Close the Template Drops dialog.
17. Open the **Point Controls** dialog and add a control to the **Slope Control** point using the following settings:

Point Controls

Corridor: 22RampB

Control Description: Controls the slope of the ramp from the road slope

Point: Slope Control

Mode: ☐ Horizontal ☐ Vertical ☒ Both

Control Type: Corridor Point

Corridor: CR 22

Reference Point: CL

Station Limits: Start: 71+72.59 Stop: 72+70.00

Horizontal Offsets: Start: 0.000 Stop: 0.000

Vertical Offsets: Start: 0.000 Stop: 0.000

Priority: 1

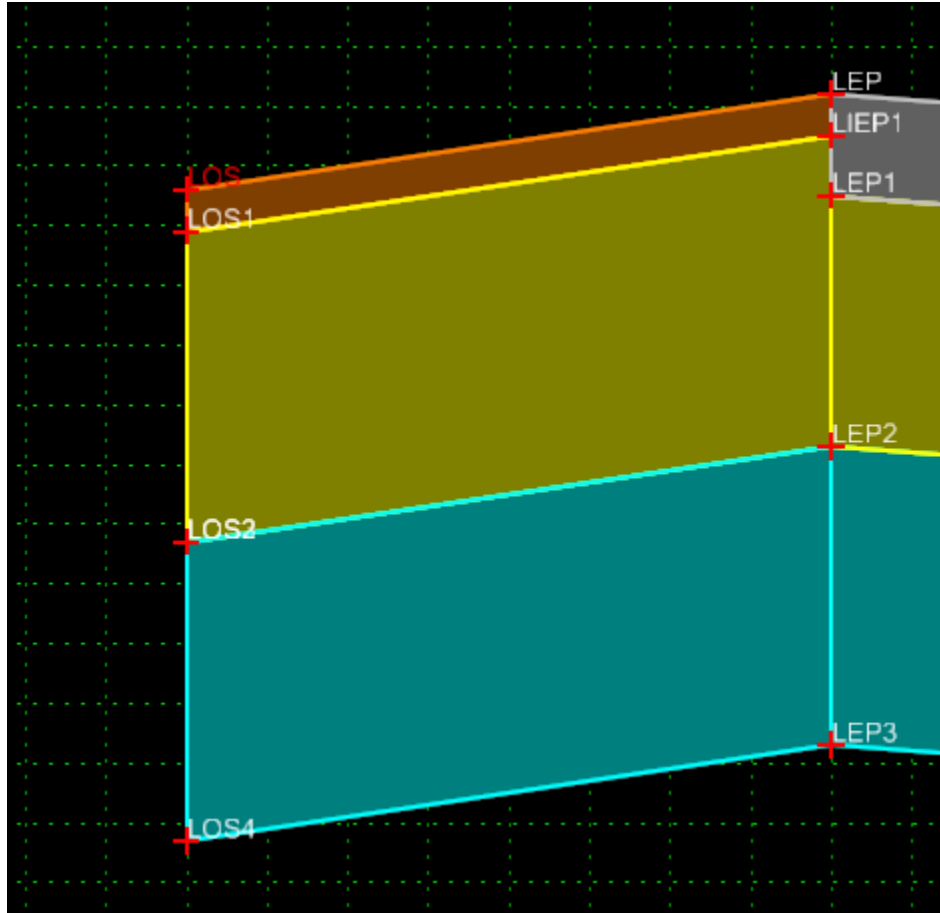
Horizontal and Vertical Controls:

E...	P...	Name	Start St...	Stop St...	Mode	Type	Control	Description
X	1	LEP	71+72.59	72+70.00	Both	Corridor P...	CR 22:REP	
X	1	LEP	72+75.00	96+83.34	Vertical	Superelev...	CL-LEP:CL	
X	1	Slope Con...	71+72.59	72+70.00	Both	Corridor P...	CR 22:CL	Controls the slope of the ramp

Delete

18. Close the **Point Controls** dialog and walk up and down the beginning of the ramp. Note that the ramp paving is now parallel to CR 22. If you tooltip over the Pavement component, you will notice that the slope is not quite 2%. That is because the ramp is not actually parallel to CR 22.
19. Next is the gore. By investigation along the ramp corridor, we can see that the gore will start at 72+75, and end at 73+05. At 73+10, we are far enough away from CR 22 to separate and start using End Conditions to tie in.
20. Open the **Template Drops** dialog and copy the template from station 72+75 to 73+10.
21. Edit the template drop at 72+75.

22. Now we want to remove all the components to the left of **LOS** (Unpaved shoulder and ECs).
23. Also, since we are in an area where we will be saw cutting the existing pavement, modify the slope and horizontal constraints on **LOS2**, **LOS3**, and **LOS4** to be **Horizontal** to **LOS** with a value of 0.0. The left side of the template should look like this:



24. Now select **OK** to close the **Edit Template** dialog and close the **Template Drops** dialog. Open the **Point Controls** dialog and add a point control for **LOS** to be controlled by **CR22 – REP** from 72+75 to 73+05.

Point Controls

Corridor: 22RampB

Control Description: Controls the gore

Point: LOS

Mode: ☐ Horizontal ☐ Vertical ☒ Both

Control Type: Corridor Point

Corridor: CR 22

Reference Point: REP

Station Limits: Start: 72+75.00 Stop: 73+05.00

Horizontal Offsets: Start: 0.000 Stop: 0.000

Vertical Offsets: Start: 0.000 Stop: 0.000

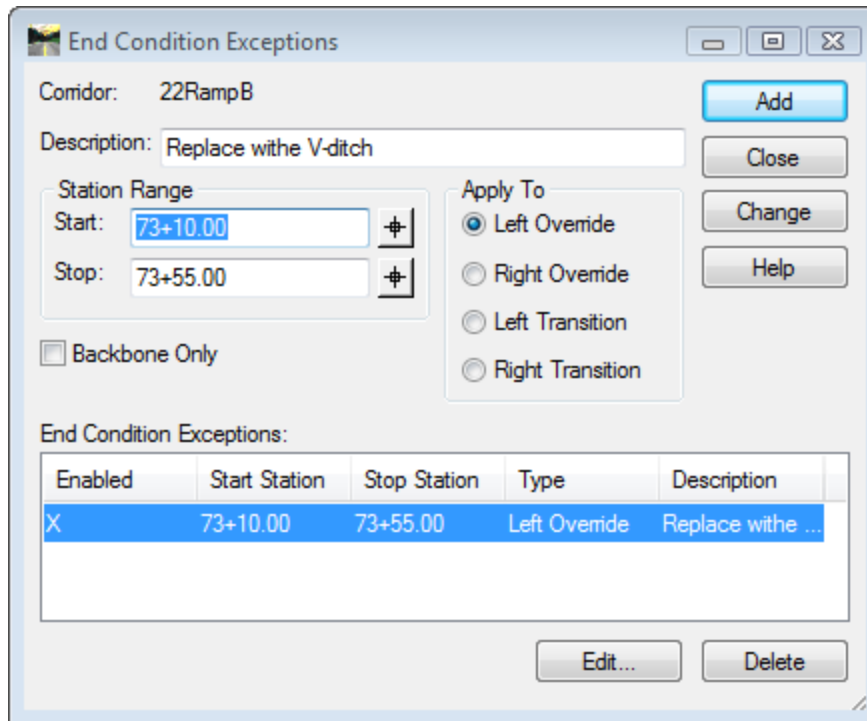
Priority: 1

Horizontal and Vertical Controls:

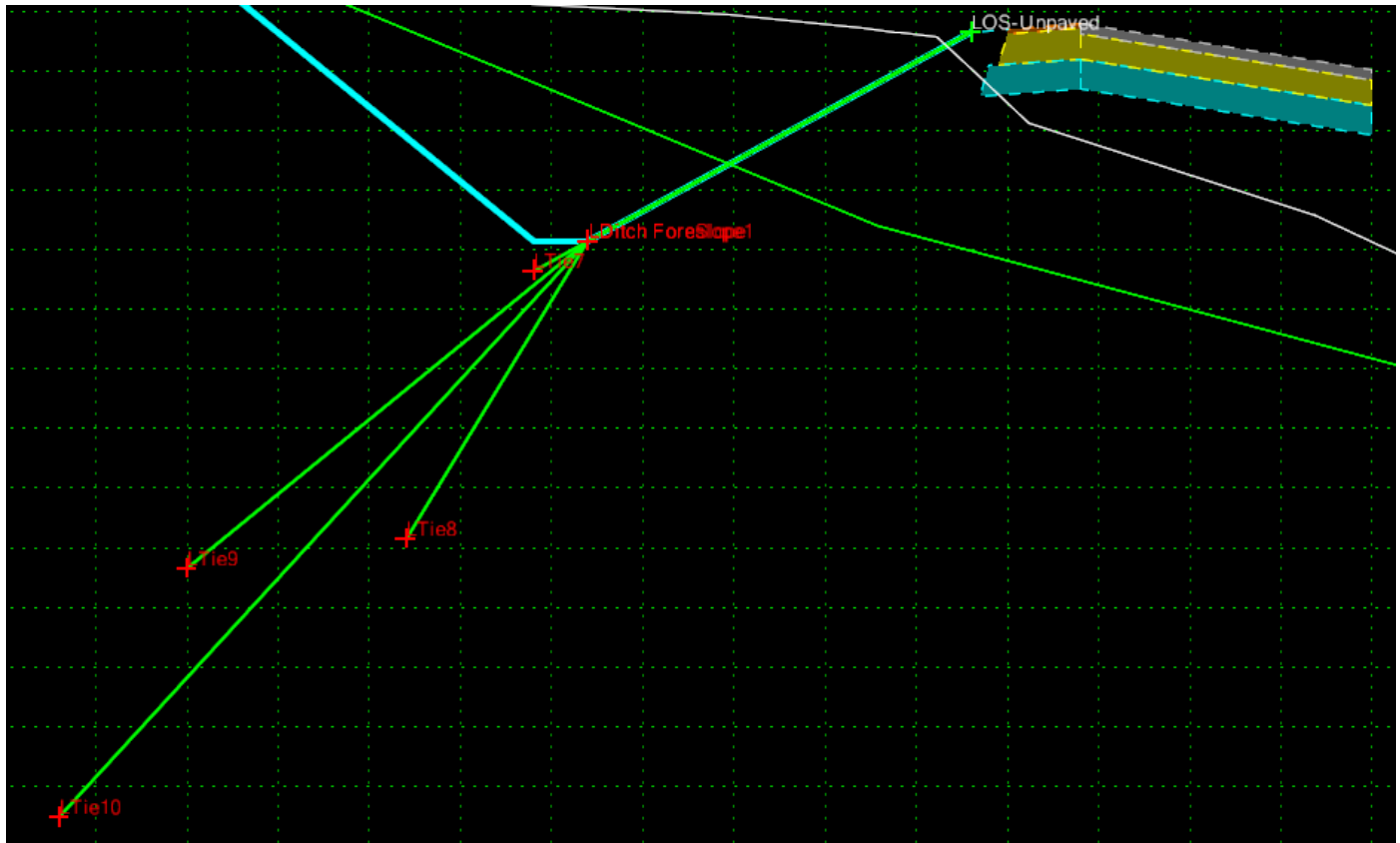
En...	Pri...	Name	Start Station	Stop Station	Mode	Type	Control	Description
X	1	LEP	71+72.59	72+70.00	Both	Corridor Point	CR 22:REP	
X	1	LEP	72+75.00	96+83.34	Vertical	Superelevati...	CL-LEP:CL	
X	1	Slope Control	71+72.59	72+70.00	Both	Corridor Point	CR 22:CL	Controls the slope o
X	1	LOS	72+75.00	73+05.00	Both	Corridor Point	CR 22:REP	Controls the gore

Delete

25. The last thing we need to do for this gore is to modify the End Conditions on the left to simple tie into CR 22 using a V-ditch. Notice by walking down the alignment, the ramp is putting in a Cut ditch from 73+10 until 73+60. You will replace this with an **End Condition Override**.
26. From the **Roadway Designer** menu, select **Corridor > End Condition Exceptions**
27. In the End Conditions Exceptions dialog, add the left side override from station 73+10 to station 73+55.



28. Once you have added the override, press the **Edit** button.
29. In the **Edit Left Override** dialog, delete the existing end condition components. This will leave a Cyan colored line showing where the current solution was.
30. Now from the **Template Library** tree view, select **End Conditions > 108U – Fill Only**. Drag it onto the existing template by clicking and holding down the left mouse button over the **108U – Fill Only** and dragging it on to the template. If you need, while still holding down the left mouse button, press CTRL-R or Right Click and select Reflect (with the right mouse button). Drop the end condition on the end (LOS-UnPaved) where the previous end condition was attached.



31. Close out of the **Edit Override** dialog by pressing **OK**. Close the **End Condition Exception** dialog. Walk up and down the range of the end condition exception to make sure it is working properly.
32. In the Roadway Designer dialog, select File > Save to save the Roadway Design Project.

LESSON NAME: CREATING THE GORE – METHOD 2

LESSON OBJECTIVE:

This lesson will show you how to design the ramp and gore area for a ramp being added to a new road. It will use several of the tools available in **Roadway Designer**

[On-Line Help Topic](#): Search on “Roadway Designer”

EXERCISE: CREATING THE GORE – METHOD 2

This exercise will take you through tying in a ramp to new road construction. This method is very similar to Method 1, except that we handle the tapering part of the ramp differently. In this case the tapering part of the ramp is part of the main roadway and is designed as such.

1. On the **Roadway Designer** move to the end of 22RampB and walk back until you get to a point where there is about ½ foot separation between LEP and the REOP of Corr_X (approximately station 93+65).
2. This point is going to be our new end of corridor location. From the menu, select **Corridor > Corridor Management**.
3. In the **Manage Corridors** dialog, select 22RampB and change the station limits to be from 71+72.59 to 93+65. Once you've made the change, close the dialog.
4. Press the **Process All** button and move to the end of the corridor.
5. Switch the Corridor to Corr_X. Notice that the location on Corr_X is at the closest location to the station we were on when Ramp22B was the active corridor. Also notice that the yellow station line overlaps the RampB Extents lines a little bit. By Investigation (*Hint – Key in different statons in the **Station** field and press the tab key to insert them into the key station list*), it looks like a93+80 would probably be a good point to start to control the edge of Corr_X with 22RampB horizontal alignment.
6. Add a horizontal point control to Corr_X REOP as follows:

Corridor: Corr_X

Control Description: Ramp B Taper

Point: ROEP

Mode:
☒ Horizontal
☐ Vertical
☐ Both

Control Type: Alignment

Horizontal Alignment: 22RampB

☐ Use as Secondary Alignment

Priority: 1

Station Limits
 Start: a 93+80.00
 Stop: a 97+00.00

Horizontal Offsets
 Start: 0.000
 Stop: 0.000

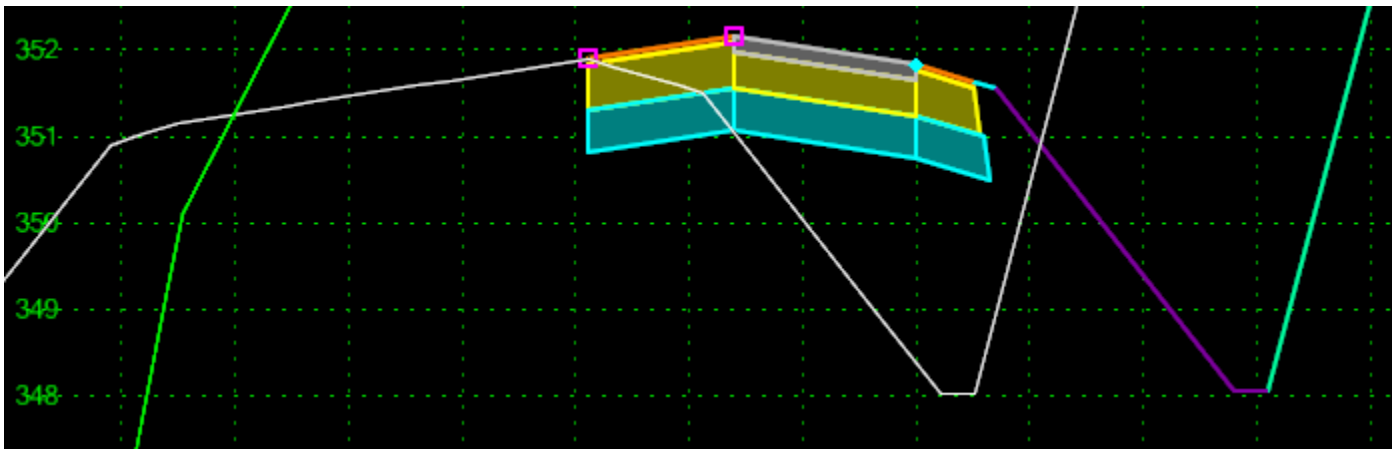
Vertical Offsets
 Start: 0.000
 Stop: 0.000

Horizontal and Vertical Controls:

En...	Pri...	Name	Start Station	Stop Station	Mode	Type	Control	Description
X	1	LEPatRamp	a 157+51.70	a 161+80.87	Vertical	Superelevati...	LtSide-LEPa...	
X	1	ROEP	a 93+80.00	a 97+00.00	Horizontal	Alignment	22RampB	

Buttons: Add, Close, Change, Help, Delete

7. Review Corr_X in the area of the change and switch back to 22RampB corridor.
8. Again we want to create the gore area. By walking from the end of the corridor, backwards, you will find that point where the ramp end condition starts tying into the side slope of Corr_X is at approximately station 89+55. There needs to be a new Template Drop at 89+60 that is the same as the one at 72+75, so you need to copy the second template drop at 72+75 to 89+60. Do this now using the Template Drops dialog.
9. Now add a point control (Both) for LOS to Corr_X – ROEP from 89+60 to the end of the corridor. After you've done this, the cross section at 89+60 should look something like this:



10. Next we need to do the End Condition Overrides to tie the ramp corridor properly into the main road corridor. By walking backwards from station 89+55 we see that we can do the same End Condition Override from 89+55 to 86+05. Do this now. Create the End Condition override and replace the current end condition with **108U – Fill Only**.
11. Lastly, looking at stations 85+95 – 86+00, we need to do something different. What we want to do is to tie the Ditch Foreslope point to the outside ditch bottom point on Corr_X. Create another End Condition Override on the left side from station 85+95 to 86+00 and edit it.
12. Delete component “LCut2” and delete Point “LDitch Bottom”.
13. Edit Point “L Ditch Foreslope” and change its properties by turning on **Check for Interception** and **Place Point at Interception**.
14. Edit Component “LDitch” and Change its **Target Type** to “Feature XYZ”. For the **Surface** name Key in “Corridor”, and for the **Point** name, Key in “Ditch Bottom”.
15. Close the **Edit Override** dialog by Pressing **OK**, and Close the **End Condition Exceptions** dialog.
16. Open the **Target Aliasing** dialog and Set the **Target** to “Corridor-Ditch bottom. In the **Surface Feature** list, select “Corridor-Corr_X:RDitch Bottom” and Add it to the **Aliases** list.
17. Save your IRD file.

LESSON NAME: ADDING DIVIDER BETWEEN RAMPS

LESSON OBJECTIVE:

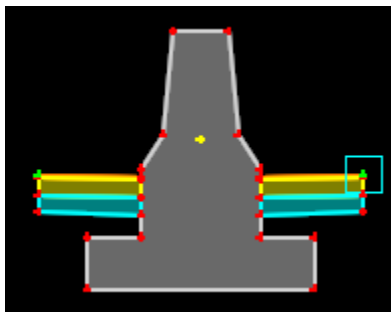
This lesson will cover what to do in an area where two corridors are too close to one another for standard End Conditions to take care of it.

[On-Line Help Topic](#): Search on "Roadway Designer"

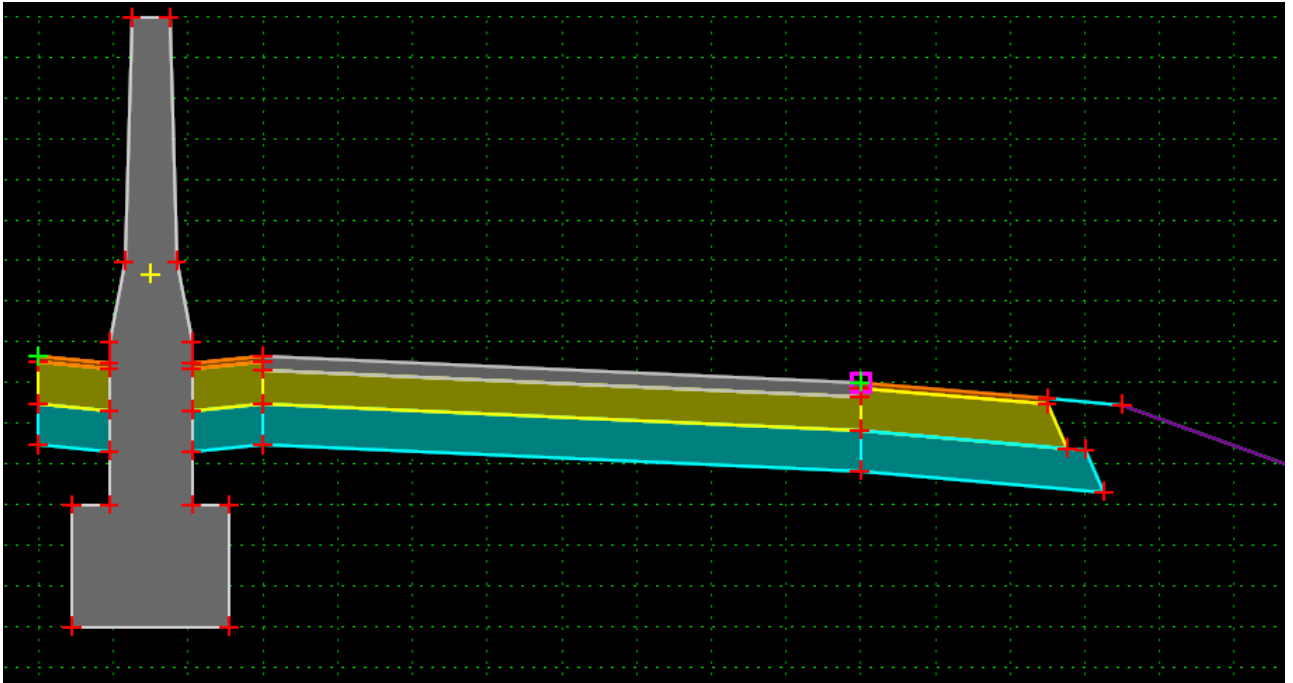
EXERCISE: ADDING DIVIDER

This exercise will take you through adding a jersey barrier divider between to corridors.

1. On the **Roadway Designer** view 22RampB Corridor and walk up and down it in the area of 22LoopA. Note that, between stations 75+35 and 79+45, it looks like it is too close to use the standard End Condition Override that was used in the start end ending gores.
2. Create two new template drops at 75+35 and 79+55 by copying the template drop at 73+10
3. Edit the template drop at 75+35 – the start of our special case.
4. Delete all the components outside of LEP
5. In the components folder of the Template Library tree view, select the "Jersey Median" component template.
6. We want to drag this template such that the top right point(Green) is dropped on LEP. To do this, Drag it from the preview window in the bottom right by selecting(Left click and hold) the point in the preview window. When you do this, a blue box in the preview window will indicate the drag point. (You will probably have to turnoff Reflect Mode when you are dragging.



If you do this properly, the template should look something like this:



7. Now add a Point Control for LConnect_L to Corridor Point 22LoopA – LEP from station 75+35 to 79+50.
8. Review the results.
9. As a final exercise, add the appropriate End Condition Exceptions to both ends of the jersey barrier section to complete the design.